SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, AUGUST 10, 1906.

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THE NATURE AND ORIGIN OF VOLCANIC HEAT.

THE hypothesis of a molten or more or less fluid interior, as possessed by the earth, may now be said to have been abandoned, and along with it the supposition that volcanoes constitute vents for the escape, as a consequence of shrinkage and subsidence, of a portion of the molten content lying everywhere under the solid crust. The hypothesis that the interior of the earth, while in the main solid, has cavities containing melted matter which occasionally is forced out in the form of eruptive outbursts is a kindred one which has found some adherents. But a truly solid interior seems to be demanded by the accepted great rigidity of the body of the earth, and Mallet has put forward the idea that extraordinary pressures exerted to crush the rocks would result in their becoming heated and melted. Evidently, however, mere pressure acting alone, however great, would not suffice for this. Incipient fluidity would substantially put an end to the crushing process and heat generation would stop. The observed high temperatures attained by volcanic products during eruption would not be reached. More recently the thermal effects of volcanoes, and the various results thereof, have been ascribed by one authority to the presence of radium, which, as is known, continuously gives out energy in its breaking up. But volcanic lavas have not been found to be sources of radium or of uranium, the amount of which should be

quite large if the supposition is to be given any serious consideration.

The object of this paper is to present a view of the origin of volcanic heat which may possess some elements of novelty and, it is hoped, of rationality. According to this view, much of the heat manifested is due to mechanical work converted into heat, a theory based upon dynamical principles to be later pointed out. Primarily it will be admitted that any substance, gas, liquid or solid, upon which work is done acquires heat in proportion to the energy expended upon it, which heat, if prevented from escaping, at once results in an increase of temperature of the substance. If the mechanical energy so converted be of known amount, we may calculate from the mass and specific heat of the substance or body upon which such energy is expended the rise in temperature. Even if air at ordinary temperature under high pressure escapes through a tortuous or frictional passage surrounded by a good heat non-conductor, it emerges hot. The higher the pressure and the greater the friction met in the passage the greater the increase. The heating is directly related to the work done upon the mass.

If a liquid be substituted for the air the general result is the same, and the liquid may be made to boil upon its escape. If a somewhat plastic solid like hard pitch be subjected to the process, the energy required will be greatly increased, or the pressure required to force it through the tortuous passage of some length will be great. It may emerge hot and melted if the conditions be properly selected.

If now it be assumed that any solid be subjected to a pressure such as to cause it to flow in a tortuous or restricted channel, it will, in so moving, rise in temperature, and continue so to rise until it has reached a degree of fluidity such as to lessen or practically stop the absorption of energy in moving the mass; or until it escapes from the passage through which it is being impelled. The pressure is but one factor of the energy, the other being the distance through which the pressure acts. The pressure required depends upon the resistance to motion, which in turn is greater with more rigid bodies and greater with increase of distance through which friction is met and overcome. The pressure or force required will be at a maximum when the solid mass starts cold or nearly so and will diminish as the temperature is raised and consequent plasticity or fluidity brought about. A rock mass forced to move under great pressure over distances of thousands of feet must soon become melted in the process. It is not necessary to assume that the mass so heated starts cold. It may start at any temperature at which it possesses sufficient rigidity or viscosity to require the exertion of great force to move it in the assumed restricted or tortuous passage or channel. Great velocity of movement in such passage means of course great energy expenditure and rapid heating. The idea thus outlined may now be applied as an explanation of volcanic phenomena. For example, a hot-water spring may be the result of the water having been forced by high pressure to traverse somewhat porous rock, or to pass through narrow but long fissures in which it is churned for a long time before escaping. In like manner any rock mass which, subjected to very high pressure, begins to flow must become heated. If its distance of traverse be great enough in a restricted fissure or channel, it must melt, or even become so heated as to partially vaporize when the pressure is relieved, as when it finally escapes. Let it be admitted that the flexures taking place in the earth's crust or in the outer portions of its mass

may bring to bear upon deep-seated and perhaps already heated solid rock masses a sufficient pressure to cause them to readjust their positions, and the condition demanded by the theory is present. Such a condition would mean movement of such masses over considerable distances at high pressures, with the final result of the formation of molten streams ready to escape upward from the pressure exerted upon them. A vent would at last form and the rush of the partially melted rocks towards and out of this vent would become a lava flow. These actions would naturally occur at places of flexure such as would tend to form a ridge, and the loading and sinking of sea bottoms as a consequence of sedimentary deposits would be favorable, as is well known, to such flexure as would tend to heavily compress the rocks along the line of flexure deep down from the earth's surface, while relieving or not increasing pressure near the surface. The compressed rock would in general tend to be shifted or made to flow outward at the line of flexure. This view accords well with the facts. Volcanoes exist along lines more or less parallel to or adjacent to sea coasts or along the weak lines in the earth's surface. It will easily be seen that a single volcanic vent or pipe may serve to relieve or provide a point for outflow for the shifting of material over a great length of flexure deep down under the earth's surface. As the flow and fusion would be a somewhat gradual process it may well be that only when the vent is about to open will there be earthquakes and great subterranean noises, more or less local to the place of outbreak. Very probably eruptions in which melted lava does not appear to have a part, but in which steam and gases, sand, or mud are ejected, are nevertheless dependent upon an upthrust of lava or a subterranean lava stream, which never reaches the surface, but the temperature of which is such that, on its reaching hydrous rock strata, the water is evolved as steam at high pressure, which entering superincumbent layers gives rise to mud eruptions, or escapes from vents or fumaroles.

It would be expected that such rock masses as, under pressure, would yield most readily would be the ones to flow and form lavas. They would also be likely to be the more readily fusible masses, assuming that before the process of compression and extrusion begins they exist at a temperature more or less elevated above that at the surface of the earth. The locus of the rock flow might, therefore, be in deep regions several miles down, so deep indeed that relief of pressure could not occur by folding of upper layers or strata, which would involve the bodily uplift of rocks above, which rocks, exerting an enormous downward pressure, may be of great relative rigidity.

The view of the origin of volcanic heat here advanced makes the paroxysmal nature of volcanic eruptions almost a necessity of the case. The rocks would resist an accumulation of pressure tending to cause them to flow, but finally, under continued increase of force, they would begin to readjust themselves. This would result in heating, softening and fusion. A vent might form and thus on account of the fluidity of the moving mass the accumulated pressure would for the time be relieved. But the original causes might still exist and continue, even after cooling of the heated material in the vents, to result in pressure accumulation, renewed flow and fresh outbreaks at periods more or less remote. The final decay of volcanic action in any region would result from such a permanent readjustment of strains as to entirely relieve the rock masses of any pres-

sures which could become critical and cause flow.

During the cooling of a globe of heated and partly fused matter, such as the earth and moon are believed to have once been, the early volcanic outbursts on them would be without violence, and it seems likely that the materials ejected would have temperatures not greatly above that of the surrounding masses. An eruption at that time would be a welling up of great bodies of rather quiescent lava derived at once from the fluid contents below a but slightly cooled surface. As the further cooling made the body more solid and rigid, especially at the outside surface, the mechanical energy spent in causing an eruption would lead to higher temperatures of erupted matter, which would escape with more violence, explosions of vapor or gas would occur, partly due to vapors evolved from the melted masses upon relief of pressure at the vent, and partly the result of contact of the hot lavas with colder surrounding rocks containing gases or water. Ashes and cinders would become a feature of the eruption. At still later stages eruptions would become less frequent and vents less numerous, but the violence of the outbursts would increase, owing to the very high temperatures reached by the extruded matter during the journey towards expulsion.

It may seem somewhat paradoxical to hold that as a body, such as is the moon, cooled, the temperature of the ejected volcanic matter would rise, but in the present view this would be a consequence of the necessary exertion of greater pressures to cause eruption, owing to the enormous amount of mechanical work or energy expended, as the matter would be forced from greater depths. It happens that upon the earth much of the evidence of volcanic action in archaic or early geological times has been obliterated by erosion and sedimentation, but we have in the moon's surface a record which is not so modified or defaced.

From the whitish streaks surrounding such craters as Tycho Brahe and Copernicus, a type of crater not very numerous on the moon, which streaks are most conspicuous at the time of full moon, it is seen that there have been effects of eruptions of these great craters which extend over hundreds of miles from the craters. These whitish streaks are superimposed upon, and therefore later than, many of the other craters and markings over which they spread. These streaks are probably the depositions from condensed vapors which left the craters in almost radial lines. Inasmuch as the moon has very little atmosphere even at its lower surface and much less at the heights from which these vapors escaped in leaving the craters, the straight line or radial direction taken by them is not surprising; in fact, it is necessary. Vaporous matter escaping into a vacuum moves in precisely that way. Had the earth no atmosphere, the ashes and vapors from a volcanic crater would move away from it in just the same manner, and would be scattered in radial streaks from the notches in the crater walls and to enormous distances. If again the surface of the moon, as seems likely owing to absence of water, be covered with loose masses, or be broken instead of smooth, or be covered with pieces of rock of varying size, it is easy to understand why these whitish streaks should require for visibility a high angle of solar illumination. The condensed deposits would fall in between the boulders or stones on the surface and at low solar elevations would be in the shade or shadow of the broken pieces on the surface. That the surface of the moon, in large part, may be covered with fragments of rock, boulders and stones is probable from the great part that volcanic ac-

tion has played in giving configuration to its surface, and the absence of any influences which would alter the aspect or general make-up of the surface outside of volcanic disturbances. The markings alluded to as existing around such craters as Tycho and Copernicus, as well as the great depth and other marked characteristics of these and similar craters, declare them to be the more recent of the great volcanic outbursts on the lunar surface. They bear the impress of having been very violent, and the vapors indicate ejections hot up to the point of vaporization. If the view presented is correct, this is entirely natural. On the other hand, contrast these craters with those called Archimedes and Plato, lava plains, surrounding which we see no vapor or fume streaks, and no evidence of great violence, and we are brought to infer that these latter are the results of more ancient action in the nature of more gentle welling up from below of fused matter, not so greatly heated by the energy of expulsion. Such craters are shallow and were probably more in the nature of quiescent pools or lakes of lava than great relief vents from great depths traversed by materials at high velocity and at the high temperatures brought about by the process of superheating while moving against resistance in volcanic pipes. So far then as the moon furnishes evidence on this subject it may well repay further study, and its condition seems to confirm the position taken herein. It has sometimes been claimed that much of the explosive effect of gas and steam from volcanoes may be due to water entering or percolating through heated strata and being converted into steam at enormous pressures. But the possibility of this is doubted. The very pressure of vapor would stop the process at its outset. No water would enter a hot stratum unless forced in by a pressure in excess of that which the steam would acquire upon its generation. A boiler can not be fed with water by a pump which yields less pressure than that carried by the boiler itself.

If, however, the water be already present in a rock stratum which is invaded by hot lava rising in a volcanic fissure, then its conversion into steam and the violent emission thereof may readily take place.

It is conceivable too that considerable movement or shifting under pressure of any moist stratum over considerable distances, especially through a restricted channel, may result in heating it to a temperature sufficient to generate steam. Here again, as in the case of the rock flow before referred to, the work done in moving the particles against great resistance may under proper conditions cause an accumulation of heat energy sufficient to account for explosive effects when the material reaches a vent. Under such conditions also, the expulsion of hot mud or sand with steam may occur without the concurrence of lava flow.

The considerations herein put forward seem to furnish a basis for a dynamical theory of volcanoes. Doubtless the action of heating a flowing rock by energy expended upon it may be, and perhaps is, often supplemented by other causes, such as chemical action brought about by hot contact of substances having affinity for each other. Gaseous products under high pressures may be the consequence of the reactions. Limestone or other carbonate may be decomposed by the contact of hot lava, and carbonic acid gas in great volumes be thus liberated.

We certainly have no need of recourse to an assumption of the existence of large localized bodies and radium minerals to explain volcanic action. To say the least such an assumed store of this rare element is improbable.

The view here advanced, it is thought, presents far less difficulty. It is indeed an extension of Mallet's idea to include other factors of energy besides pressure.

The fact that the heated volcanic masses are in the earth, surrounded by materials of low heat-conducting power, makes the accumulation or retention of heat energy generated by mechanical work possible. The local character, as well as the varied nature of volcanic phenomena, is not difficult to understand. Volcanic outbursts must continue so long as readjustments of the positions of rock masses under a critical condition of pressure occur with the deeper surface layers.

If, as appears probable, the earth's interior is metallic iron, surmounted by a covering of oxidized lighter material, slag-like in character but altered by water and sedimentation, etc., the interior temperature or that of the metallic body is not likely to be very high, and it must be fairly uniform in spite of the gradual increase noted in the surface rocks at increasing depths. Such surface rocks or layers, being of relatively low heat conductivity, serve, so to speak, as a non-conducting blanket in which alone a considerable temperature gradient would be manifested. This condition does not forbid the possibility of the readjustments of masses herein regarded as the initial cause of superheating, even if those masses be quite hot but under such gravitational pressure of superincumbent masses as to forbid fusion.

ELIHU THOMSON.

THE GEOGRAPHICAL DISTRIBUTION OF THE STUDENT BODY AT A NUMBER OF EASTERN AND WESTERN UNIVERSITIES AND EASTERN COLLEGES.

THE accompanying table explains the geographical distribution of the student body of six of the leading universities of the east and of four western institutions, as well as of three New England and two Pennsylvania colleges for the academic year 1905–06, summer session students being in every instance omitted. It was impossible to secure accurate figures for the academic year just closed in the case of the *University of California,* and consequently the figures for 1904–05 were substituted. Comparing the attendance by divisions of the six eastern universities (*Columbia, Cornell, Harvard, Pennsylvania, Princeton, Yale*) with the corresponding figures for the same universities included in a similar table published in SCIENCE, N. S. Vol. XXII., No. 562 (October 6, 1905), pp. 425–6, we note in the first place that there has been a gain for these universities taken as a whole in every division, the largest increase in actual number of students, leaving the north Atlantic division—in which all of these six universities are located—out of consideration, having been recorded in foreign countries, where there has been a gain of eighty-seven students, this being as large as the entire increase of the student clientele of these universities in the United States divisions (exclusive of the north Atlantic). In the south Atlantic states and in the insular possessions these eastern universities have made only a slight gain; in the south central division all of them show an increase with the exception of *Princeton;* in the north central division the chief gains have been made by *Columbia, Princeton* and *Yale,* in the western division by *Columbia, Pennsylvania* and *Yale,* and in foreign countries by *Columbia, Cornell* and *Harvard.* These figures bear out the statement made by the writer in earlier contributions to SCIENCE to the effect that the western and southern clientele of the prominent eastern universities is not suffering any shrinkage. At *Columbia* the attendance from outside

RESIDENCES OF STUDENTS
(A) UNITED STATES

1905-1906	Amherst	California	Columbia	Cornell	Dartmouth	Harvard	Illinois	Lafayette	Lehigh	Michigan	Pennsylvania	Princeton	Williams	Wisconsin	Yale
North Atlantic Division.	**387**	**9**	**3486**	**2517**	**879**	**3494**	**26**	**324**	**509**	**490**	**2517**	**955**	**348**	**39**	**2239**
Connecticut	24		73	46	22	58		2	5	5	38	15	17		1057
Maine	3		20	13	44	116	1			9	11	3	6		28
Massachusetts	196	4	78	78	418	2383	5	1	11	18	60	24	95	5	188
New Hampshire	1		7	7	243	70			1	5	14	2	4	2	12
New Jersey	12	2	407	143	8	68	1	65	52	13	207	277	29	5	112
New York	110	3	2774	1911	54	501	12	23	47	248	130	272	173	14	608
Pennsylvania	24		95	301	6	169	6	233	392	175	2046	357	14	11	188
Rhode Island	8		11	10	6	99			1	5	7	2	1	1	25
Vermont	9		21	8	78	30	1			12	4	3	9	1	21
South Atlantic Division.	**11**	**3**	**112**	**180**	**7**	**110**	**16**	**11**	**99**	**40**	**152**	**95**	**3**	**15**	**98**
Delaware			1	9		1		3	3		32	5			13
District of Columbia	4	2	6	53	5	38	3	5	19	12	22	17	2	6	27
Florida	1		6	2		4	2			4	7	3			7
Georgia			22	12		9	3			5	8	3		3	7
Maryland	5	1	16	47	1	18	1	3	60	2	38	45	1	3	10
North Carolina			19	11		8	3		1	3	8	6		1	9
South Carolina	1		15	7	1	11	2		1	1	5	3		1	9
Virginia			20	30		13	2		10	8	16	8			10
West Virginia			7	9		8			5	5	16	5		1	6
South Central Division.	**5**	**3**	**75**	**80**	**3**	**92**	**47**		**15**	**63**	**64**	**63**	**2**	**8**	**89**
Alabama	1		14	16		9	1		1	3	13	6			7
Arkansas			5	7		8	5			7	4	4		3	1
Indian Territory			1	2			3			2		2		1	1
Kentucky	2		17	13	1	36	7		4	24	25	23	1		30
Louisiana			6	5		11	6			1	2	1			6
Mississippi		1	7	7		2	6		1	1	3	5			4
Oklahoma			1	1		6	2			10	1			1	4
Tennessee	1		10	12	1	9	4		9	3	2	9		2	14
Texas	1	2	14	17	1	11	13			12	14	13	1	1	22
North Central Division	**43**	**37**	**287**	**380**	**91**	**487**	**3299**	**9**	**6**	**3380**	**139**	**219**	**86**	**3120**	**536**
Illinois	10	8	28	121	54	106	2872	4	1	313	16	59	31	193	147
Indiana	1	1	40	28	1	39	75			163	13	24	8	24	26
Iowa	2	9	10	20	3	42	93	1		88	13	20	6	71	34
Kansas		3	13	7	1	15	21		1	34	8	4	1		18
Michigan	5	4	33	22	2	28	31	1	2	2275	8	13	3	11	37
Minnesota		2	27	9	1	30	24	2		26	9	10	8	30	45
Missouri	16	3	32	24	8	42	34			67	8	22	1	16	58
Nebraska	1	1	13	6	3	13	18			18	1	4	2	4	7
North Dakota		1	3	1		4	4			9	1			9	
Ohio	6	2	63	128	14	137	31	1	2	341	54	45	18	16	135
South Dakota		1	3	1	2	2	15			11	2	2		15	5
Wisconsin	2	2	22	13	2	29	81			35	6	16	8	2731	24
Western Division	**7**	**3202**	**117**	**75**	**15**	**124**	**47**	**2**	**1**	**149**	**37**	**31**	**5**	**25**	**93**
Arizona		3	4			1	2			3				1	1
California	1	3093	30	18	1	45	5			25	7	6	1	4	21
Colorado	3	7	19	19	12	28	13			41	8	10	1	11	33
Idaho		2	2	3		2	4			4	3				1
Montana		5	14	4		9	6			25	1	6		3	3
Nevada		5	3			1									1
New Mexico		7	1		1	4	1			7	1			2	
Oregon	1	35	9	11		11	5	1	1	7	2	4	1	3	13
Utah		7	25	10		11	4	1		16	3	3			7
Washington	2	38	8	8	1	11	7			14	12	1	1	1	11
Wyoming			2	2		1				7		1	1		2
Insular Possessions		**14**	**6**	**23**		**12**	**12**	**1**	**4**	**11**	**5**	**1**	**1**	**9**	**8**
Hawaiian Islands		9	3	5		9	1			1	1		1		6
Philippine Islands		5		12			10	1		5	2			8	1
Puerto Rico			3	6		3	1		4	5	2	1		1	1
Total	**453**	**3268**	**4083**	**3255**	**995**	**4319**	**3447**	**347**	**634**	**4133**	**2914**	**1364**	**445**	**3216**	**3063**

the north Atlantic division has increased from 15.07 per cent. to 17.65 per cent. during the last four years.

Taking the UNIVERSITIES in the accompanying table by divisions, we find that *Harvard* and *Columbia* have the largest representations in the north Atlantic division, *Cornell* and *Pennsylvania, Yale* and *Princeton* following in the order named. *Michigan's* representation has increased from 394 to 490 in one year, the other western (the term as thus used includes the north central and western divisions) universities—*California, Illinois, Wisconsin*—attracting only a few students from this section of the country. *Harvard* leads in all of the New England states with the exception of Connecticut, where *Yale* of course has the largest clientele. *Columbia* and *Cornell* naturally have the largest representation in New York state, *Yale, Harvard, Princeton* and *Michigan* following in the order named, as they did last year. *Michigan's* increase in this state—from 195 to 248—is noteworthy. In *New Jersey* the order is also identical with that of last year, namely, *Columbia, Princeton, Pennsylvania, Cornell, Yale, Harvard.* The *University of Pennsylvania* naturally leads in its own state, followed by *Princeton, Cornell, Yale, Harvard, Columbia.* Examining the attendance at the COLLEGES from these states, we note that the order for the entire division is *Dartmouth, Lehigh, Amherst, Williams, Lafayette. Dartmouth* leads the colleges in Maine and Massachusetts—*Harvard* being the only one of the universities having a larger following in these states than the New England college in question—as it does in New Hampshire and Vermont, where its following is far in excess of that of any other college or university represented in the table. Only a few students from Rhode Island attend the colleges included in the table, the students from this state being attracted in largest number to *Brown* and *Harvard.* In Connecticut the order is *Amherst, Dartmouth, Williams,* all of the eastern universities except *Princeton* having a larger representation in this state than any of the New England colleges here included. *Lafayette* and *Lehigh* have no following to speak of in any of the New England states, although they are well represented in New Jersey and New York. In the states just mentioned the order of the New England colleges is *Williams, Amherst, Dartmouth,* all three exceeding the two Pennsylvania colleges in New York and being surpassed by them in New Jersey. Of the eastern universities *Pennsylvania* has the largest percentage of enrolment from its own state, namely, 67 per cent.; of *Columbia's* student body 66 per cent. come from New York state, of *Cornell's* 56 per cent. hail from the same state, of *Harvard's* 54 per cent. are residents of Massachusetts, of *Yale's* 33 per cent. have their permanent residence in Connecticut, and finally, of *Princeton's* students only 20 per cent. are residents of the state of New Jersey. *Princeton* and *Yale* are thus the only two of the eastern universities mentioned which attract more than half of their students from outside the states in which they are respectively located. Of the three New England colleges here included, 21 per cent. of the student enrolment of *Williams* hail from Massachusetts, 24 per cent. of *Dartmouth's* student body come from New Hampshire (32 per cent. from New Hampshire and Vermont), and 43 per cent. of *Amherst's* students have their permanent home in Massachusetts. All of these colleges therefore attract the larger percentage of their student body from outside of the states in which they are respectively located, while in the case of *Lafayette* and *Lehigh* the reverse is true,

the percentage of Pennsylvania residents being 67 per cent. in the case of *Lafayette* and 60 per cent. in the case of *Lehigh*. It is also interesting to observe that *Dartmouth* draws more students from Massachusetts than it does from New Hampshire, that *Princeton* draws more students from Pennsylvania than from New Jersey, and that *Williams* attracts more from New York than from Massachusetts.

Coming next to the south Atlantic division, we see that the students from this section are attracted to the six eastern universities in the same order as last year, namely, *Cornell, Pennsylvania, Columbia, Harvard, Yale, Princeton.* *Michigan* is the only one of the three western universities here included that makes any showing in this division, being exceeded by all of the eastern universities, while of the colleges *Lehigh* is the only one that is at all well represented, the south Atlantic following of this institution being in excess even of that of *Princeton.* As far as the individual states are concerned, *Pennsylvania* leads in Delaware, *Cornell* in the District of Columbia and in Virginia, *Pennsylvania* and *Yale* in Florida, *Columbia* in Georgia, North Carolina and South Carolina, *Lehigh* in Maryland, and *Pennsylvania* in West Virginia.

In the south central division *Harvard* heads the list (92 as against 80 last year), with *Yale* (89–80), *Cornell* (80–76), *Columbia* (75–72), *Pennsylvania* (64–44), *Michigan* (63–64), *Princeton* (63–72), *Illinois* (47–47) and *Lehigh* following in the order given, the representation from this section of the other institutions in the list being insignificant. The largest representation in the individual states is found at the following universities: Alabama—*Cornell, Columbia, Pennsylvania;* Arkansas—*Harvard;* Indian Territory—*Illinois;* Kentucky—*Harvard, Yale, Pennsylvania;* Louisiana—*Harvard;* Mississippi—*Columbia* and *Cornell;* Oklahoma—*Michigan;* Tennessee—*Yale, Cornell, Columbia;* and Texas—*Yale, Cornell, Columbia* and *Pennsylvania.* Kentucky sends by far the largest delegation to the institutions included in the list.

In the north central division the three universities of that section, *Michigan, Illinois* and *Wisconsin,* naturally head the list, ranking in the order named. Of the three institutions *Michigan* draws the largest percentage of students from outside of its own state, 54 per cent. of its enrolment hailing from Michigan, the corresponding figures for *Illinois* and *Wisconsin* being 83 per cent. and 84 per cent., respectively. It is thus seen that the clientele of the *Universities of Illinois* and *Wisconsin* is much more local in character than that of any of the eastern colleges or universities included in the table, whereas *Michigan* attracts a larger percentage of students from outside its own state than do *Pennsylvania, Columbia* and *Cornell* or *Lafayette* and *Lehigh, Harvard's* percentage being just equal to that of the *University of Michigan.* Of the eastern universities *Yale* has the largest clientele in this section of the country, followed by *Harvard, Cornell, Columbia, Princeton* and *Pennsylvania,* in the order named, *Yale* and *Harvard* having exchanged rank since last year. Comparing the figures for the past academic year with those for 1904–05, we see that *Yale's* representation has increased from 506 to 536, the greatest gain (119–135) having been made in the state of Ohio; *Harvard* has dropped from 526 to 487, the largest loss (160–137) having been experienced in the same state; *Cornell's* representation in this division has remained stationary, 381–380, *Columbia's* has grown from 262 to 287, *Princeton* has 219 this year as against 209 in 1904–05, while *Penn-*

sylvania has the same number, 139. Of the New England colleges *Dartmouth* has the largest following in the north central division, with *Williams* a close second, the latter having twice as many students from this section as *Amherst*. The representation of *Lafayette* and *Lehigh* in this as well as in the western division is insignificant. *California* has thirty-seven representatives from this division, which is less than that of any of the other universities or the New England colleges. Leaving the *University of Illinois* out of consideration, *Michigan* has the largest following in Illinois, followed by *Wisconsin, Yale, Cornell* and *Harvard,* each of which has over one hundred students from this state. *Michigan* also leads in Indiana, followed by *Illinois, Columbia, Harvard* and *Cornell.* In Iowa the order is *Illinois, Michigan, Wisconsin, Harvard* and *Yale;* in Kansas, *Michigan, Illinois, Yale, Harvard, Columbia;* in Michigan (leaving the state university out of consideration) *Yale, Columbia, Illinois, Harvard, Cornell;* in Minnesota, *Yale, Harvard, Wisconsin, Columbia, Michigan;* in Missouri, *Michigan, Yale, Harvard, Illinois, Columbia;* in Nebraska, *Illinois* and *Michigan, Columbia* and *Harvard;* in North Dakota, *Michigan* and *Wisconsin;* in Ohio, *Michigan, Harvard, Yale, Cornell, Columbia;* in South Dakota, *Illinois* and *Wisconsin, Michigan;* in Wisconsin (leaving the state university out of consideration), *Illinois, Michigan, Harvard, Yale, Columbia.* The largest number of students attracted to *Amherst* from this section hail from Missouri, while the main strength of *Dartmouth* and *Williams* lies in Illinois. Excluding in each case the respective state university, the state of Illinois is represented by 1,091 students at the institutions mentioned in the list, Wisconsin by 240 and Michigan by 200, *i. e.,* 72 per cent. of the state of Illinois representatives at all of the institutions included in the table are enrolled at the state university, while the percentage for Michigan and Wisconsin is 92.

In the western division (leaving *California* out of consideration) *Michigan* leads, as it did last year, with *Harvard* and *Columbia,* each of which attracts over one hundred students from this section, following; then come *Yale, Cornell, Illinois, Pennsylvania, Princeton. Amherst* and *Williams* attract only a few students from this division, *Dartmouth* being well represented only in Colorado. *Michigan* has grown from 134 to 149, its chief gain having been registered in Colorado; *Harvard* has dropped from 126 to 124, its main loss being in California; *Columbia* has grown from 111 to 117, the largest gain being in Utah; and *Yale* has grown from 78 to 93, the best gain being in Colorado. *Columbia* leads in Arizona, although the number is so small as to render the comparison of little value; in California *Harvard* still leads—leaving the state university out of consideration—with *Columbia* second; in Colorado the order is *Michigan, Yale, Harvard;* in Idaho, *Illinois* and *Michigan;* in Montana, *Michigan, Columbia, Harvard;* in Nevada, *California, Columbia;* in New Mexico, *California* and *Michigan, Harvard;* in Oregon, *California, Yale, Cornell* and *Harvard;* in Utah, *Columbia, Michigan;* in Washington, *California, Michigan, Pennsylvania;* and in Wyoming, *Michigan* leads. Of the states in the western division Colorado and California send by far the largest delegations to the eastern institutions in the list. The fact that the *California* figures are those for 1904–05 somewhat mars the value of the comparisons in this division, although the figures for the academic year just closed would probably show little change. The attendance of students from the state of Cali-

fornia at the eastern institutions will undoubtedly suffer a considerable loss in the coming year.

Cornell again leads in the number of students from the insular possessions, with *California* second, and *Harvard* and *Illinois*

(B) FOREIGN COUNTRIES

1905-1906	Amherst	California	Columbia	Cornell	Dartmouth	Harvard	Illinois	Lafayette	Lehigh	Michigan	Pennsylvania	Princeton	Williams	Wisconsin	Yale
North America	**2**	**7**	**46**	**48**	**2**	**51**	**10**		**17**	**21**	**37**	**7**		**11**	**27**
Canada	2	6	31	26	1	40	3		1	13	8	4		1	25
Central America			1	4			1				13			1	
Cuba			7	12		2			9		7	2		1	
Mexico		1	6	6	1	6	6		5	7	3	1		5	1
West Indies			1			3			2	1	6			3	1
South America		**2**	**9**	**30**		**1**			**3**	**2**	**9**			**5**	**1**
Argentine Republic		1	2	7		1								4	
Brazil			1	11							6			1	1
Chili			3							1	3				
Colombia			2	1					1	1					
Ecuador				2					1						
Peru		1	1	9					1						
Europe	**1**	**5**	**50**	**22**	**1**	**32**	**6**		**1**	**12**	**49**	**7**		**4**	**21**
Austria-Hungary			2								2				
Belgium			1								1				
Bulgaria				1						1	1				
Denmark		1												1	1
France	1		8	1		6					15	1			3
Germany		1	12	2		6	1			3	5	5		2	
Great Britain and Ireland		3	11	4		9				2	10			1	4
Holland			1	2		1				2	1				
Iceland						1									
Italy			2			3	1				4				
Norway				3		1	2								1
Portugal							1								
Rumania											1				
Russia			6	2							7				
Spain			2				1								
Sweden			2	2					1		1				
Switzerland			1	1											
Turkey			2	4	1	5				4	1	1			12
Asia	**4**	**18**	**38**	**20**		**21**		**3**		**12**	**14**	**5**	**2**	**6**	**31**
Ceylon												1			
China		9	10	9		3		1		1	1				4
India	1	1	3	7		1		2		2	1		1		1
Japan	3	8	24	4		16				9	11	4	1	6	24
Persia			1												
Turkey (in Asia)						1					1				2
Africa		**1**	**4**	**2**		**2**	**1**		**1**			**1**	**1**		**2**
Cape Colony												1			
Egypt							1								
Morocco						1									
South Africa		1	4	2		1			1				1		2
Australasia		**6**	**3**	**8**		**5**	**1**				**21**				**3**
Australia		3	2	7		1					14				3
Friendly Islands		1													
New Zealand		2	1	1		4	1				7				
Total (Foreign Countries)	**7**	**39**	**150**	**130**	**3**	**112**	**18**	**3**	**22**	**47**	**130**	**20**	**3**	**26**	**85**
Total (United States)	453	3268	4083	3255	995	4319	3447	347	634	4133	2914	1364	445	3216	3063
Grand Total	**460**	**3307**	**4233**	**3385**	**998**	**4431**	**3465**	**350**	**656**	**4180**	**3044**	**1384**	**448**	**3242**	**3148***

*Omitting 64 non-resident graduate students.

third. *California* leads in the Hawaiian Islands, and *Cornell* in the Philippines and in Puerto Rico. There is quite an increase in the total number of students from the Philippine Islands and Puerto Rico over last year at the universities included in both this and last year's tables. Alaska is not represented this year at any of the institutions in the list.

As was pointed out in the introductory paragraph, the gain during the past year in the number of students from foreign countries has been quite marked, the increase for the six eastern universities included being one from 540 to 627, a growth of no less than 16 per cent., to which the various continents contributed as follows: North America's representation has grown from 212 to 216; South America's from 37 to 50; Europe's from 116 to 181; Asia's from 107 to 129; Africa's remained stationary at 11, and Australasia's has dropped from 57 to 40, this loss being attributable chiefly to the decrease of 15 in the figures for the *University of Pennsylvania*, which attracts the largest number of Australasians.[1] A glance at the accompanying table will show that *Columbia* has the largest foreign clientele, having exchanged places with the *University of Pennsylvania*, which this year is tied with *Cornell* for second place, *Harvard* occupying fourth, as it did last year. The attendance from foreign countries at *Columbia* has grown from 117 to 150 during the past year, that of *Cornell* from 100 to 130, that of *Pennsylvania* from 126 to 130, that of *Harvard* from 94 to 112, that of *Yale* from 83 to 85, that of *Michigan* from 38 to 47, and that of *Princeton* has remained stationary at 20. Of the western universities *Michigan* attracts the largest number of students resident in foreign countries, followed by *California, Wisconsin* and *Illinois* in the order named. It will also be noted that the attendance of foreigners is almost exclusively confined to the larger universities, although *Lehigh* during 1905–06 attracted 22, as against 7 for *Amherst*, and 3 each for *Dartmouth, Lafayette* and *Williams*. *Lehigh's* excellent showing in this direction is explained by its reputation as a technological school, this particular field being the one that draws the majority of foreign students, although the foreign clientele in the non-professional graduate faculties of the larger universities is rapidly on the increase. It is safe to predict that the growth in the number of foreigners attending our higher institutions of learning will be as uninterrupted in the immediate future as it has been during the past few years. Examining the representation of the different institutions by continents, we note that the order in North America is *Harvard, Cornell, Columbia, Pennsylvania, Yale, Michigan;* in South America, *Cornell, Columbia* and *Pennsylvania, Wisconsin—Cornell* being the only institution in the list that makes a respectable showing; in Europe, *Columbia, Pennsylvania, Harvard, Cornell, Yale, Michigan;* in Asia, *Columbia, Yale, Harvard, Cornell, California, Pennsylvania;* in Africa *Columbia* leads, while in Australasia the order is *Pennsylvania, Cornell, California, Harvard*. The two most interesting phenomena to be observed here are the rapidly increasing delegations from Europe on one hand, and on the other the comparatively meager showing made by South America. It certainly seems strange that the South American republics are not better represented by students at the universities of the United States. As for individual countries, *Harvard* leads in Canada, followed by *Columbia, Cornell* and *Yale; Pennsylvania* has the best Central American representation; *Cornell* attracts the largest num-

[1] A portion of the information contained in this paragraph was published in the *New York Evening Post* of July 21, 1906.

ber of Cubans, *Michigan* the largest number of Mexicans and *Pennsylvania* the largest number of West Indians. Of the North American countries, Canada sends the largest number of students—161—followed by Mexico with 48 and Cuba with 40. *Cornell* leads in the Argentine Republic, Brazil, Ecuador and Peru; *Columbia* in Colombia, and with *Pennsylvania* in Chili, although the representation in the last two countries is insignificant. Of the South American countries, Brazil sends the largest representation, namely, 20, followed by the Argentine Republic with 15 and Peru with 12. In the European countries that send ten or more students the order is as follows: France—*Pennsylvania, Columbia, Harvard;* Germany—*Columbia, Harvard;* Great Britain and Ireland—*Columbia, Pennsylvania, Harvard;* Italy—*Pennsylvania, Harvard;* Russia—*Pennsylvania, Columbia;* Turkey—*Yale, Harvard.* Great Britain and Ireland sends the largest number, namely, 44, followed by Germany with 37, France with 35 and Turkey with 30. Of the Asiatic countries, Japan sends 110, China 38 and India 20, the representation from the other countries being unimportant. *Columbia* draws the largest number of students from China, leads with *Yale* in Japan, and follows *Cornell* in India. Of the Australasian countries, Australia sends 30 and New Zealand 16, *Pennsylvania* leading in both, followed by *Cornell* in the former and by *Harvard* in the latter.

RUDOLF TOMBO, JR.

SCIENTIFIC BOOKS.

The Analysis of Racial Descent in Animals. By THOMAS H. MONTGOMERY, JR., Professor of Zoology in the University of Texas. Pp. xi + 311. Henry Holt & Co. $2.50.

A general and comprehensive work on the methods of determining racial descent has not appeared within recent years and Haeckel's 'Generelle Morphologie,' first published in 1866, still remains the standard work on this subject. The insufficiency of some of the methods outlined by Haeckel has been repeatedly pointed out, but there are few, if any, works which deal with these methods both critically and constructively. Recent analytical studies in biology have turned the interest and sympathies of many biologists away from the more general, if less exact, speculations of the older school, and have brought the study of phylogeny into a certain disrepute. Nevertheless, as the author says in his preface, "many of the broader concepts of biology have been obtained from just such investigations. As to the degree of uncertainty in its conclusions, this results simply from the great extent of the phenomena to be explained and from their complexity."

The first chapter of this work deals with 'Environmental Modes of Existence.' In addition to the general classification of organisms into the *geobios, limnobios* and *halobios* of Haeckel, the author recognizes two other groups—the *diplobios* (organisms which spend part of their life in one medium, part in another) and the *entobios* (entoparasites); the first three of these modes of existence he groups together under the name *monobios,* the last two under *heterobios.*

The question as to which of these modes of existence is the most primitive is interestingly discussed and the conclusion reached that the evidence favors the hypothesis of Simroth that 'the sea beach from the region of high tidal limit to a short distance below the low tidal, is the probable point of origin of most animal groups.'

Regarding the seasonal migrations of various animals the author concludes that there is no evidence that the earliest environment of the young represents the ancestral home of the species. As to the method of origin of entoparasites he concludes that where there are a number of different hosts in the life history of the parasite, *e. g.,* Trematodes, the host in which the adult condition is reached is the primitive one, whereas the occurrence of younger stages in an intermediate host is a later adaptation. "Here the ontogeny would be a reversal of the phylogeny with regard to the sequence of hosts."

In the second chapter on 'Heredity and Embryonic Differentiation' the author gives a brief account of the statistical, and a more extended account of the cytological studies of heredity. He calls attention to the importance of the nuclear linin in the preservation of the characteristic number and form of the chromosomes and he concludes that the linin should always be considered along with the chromatin and that both linin and chromatin constitute the germ-plasm. The hereditary significance of the conjugation of male and female chromosomes, and of their separation in the reduction division first discovered by the author, is discussed. In his treatment of embryonic differentiation the position is taken that the ability of egg fragments to give rise to whole embryos, no more indicates the undifferentiated character of the fragments than the similar ability on the part of adult planarians.

The third chapter on the 'Relations of Modes of Reproduction and Conjugation' is less convincing in its conclusions than the preceding ones. The evidence presented in favor of the view that fragmentation is more primitive than binary fission is not convincing; and the same is true of the conclusion that Geddes and Thompson's theory of sex must be abandoned because sexuality is 'the state of occurrence of dissimilar individuals,' only one of which, the egg, has the power to reproduce. Similarly the conclusion that the male is morphologically and physiologically inferior to the female, while supported by many examples, meets with so many exceptions as to cast doubt upon its general applicability or value. The statement that 'sexuality finds its expression and origin in extra-chromosomal differences' does not accord with the recent careful work of Stevens and Wilson. And the statement that every Metazoan formed from a fertilized egg cell is initially a hermaphrodite, because formed by the fusion of male and female germ cells, while an animal arising from an unfertilized egg is initially female, though it may later become male, seems to the reviewer to confuse sex with sex cells and thereby to create many needless difficulties. Finally the evidence brought forward at the close of the chapter in favor of the view that 'eventual hermaphroditism' is a secondary condition and not primitive is not wholly satisfactory, for it does not necessarily follow that 'because of its [separate sexes] more general occurrence it would seem to be more primitive.'

The fourth chapter contains an extensive treatment of 'Life Cycles and Polymorphism of Individuals.' The author concludes that 'all cases of metagenesis have originated from larval development, and that asexual reproduction is limited to an immature or larval stage.' Practically he makes no distinction between larval development with metamorphosis and metagenesis, or in his own words, 'All discontinuous larval development is metagenetic, in that the adult is formed asexually, by budding from the larva.' This discussion is of service in showing that there is no hard and fast line between metagenesis and discontinuous larval development, but there seems to be no good reason for changing the old definition of metagenesis, viz., 'an alternation of a sexually produced generation or person with an asexually produced one,' for this new definition, even though in some cases there may be no sharp line of demarcation between the alternation of 'persons' in metagenesis with the alternation of 'organs' in larval development.

Under 'ekdytic development' the author includes those cases, commonly known as fetal development, in which special annexes are formed, which are later lost. He considers that Beard is right in classifying fetal development as discontinuous, but wrong in regarding it as a form of larval development.

The fifth chapter deals with 'Variations and Mutations' and represents in a brief form the relations of the mutation theory of de Vries to the germ-plasm theory of Weismann. The tabular classification (p. 135) of the conditions of variation and mutation, and of the resulting types of variants and mutants is a brief and useful summary. As to the cause of atypical forms he says (p. 146): 'Our conclusion is that variation, progressive or regressive, and also mutation, in fact any inherited modification of the race, is instituted by stimulus of the environment'; and again

he says (p. 149): "It follows, accordingly, that in neither of the known kinds of bastardization, the Mendelian or the unisexual, is there any evidence that variations or mutations are produced by these processes. Parental qualities are transmitted according to more or less definite laws, but no new ones are produced." On the basis of such considerations he concludes that acquired characters are inherited. "Indeed the very postulation of the question, 'are acquired characters inherited?' is absurd. It should read rather, 'what kinds of acquired characters become inherited?'" Regarding the statement of de Vries that the answer to this question 'depends to a great extent upon a word play; just according as one chooses his definition for acquired characters, he regards them as heritable or not,' Montgomery says:

> Here, however, de Vries himself makes a word play; acquired characters, according to him, are those only which do not arise suddenly, *i. e.*, individual variations and not mutations. But according to all essential ideas of his mutation theory the mutations are much more distinctly, even solely, steps in the formation of races, and a step in racial progress is surely nothing less than an acquisition.

This is as striking an illustration as could be found of the need of clear definitions, and of the fact that long continued discussions in science more frequently arise from misunderstandings than from fundamental differences of opinion. For what Montgomery calls 'acquired characters' or 'steps in racial progress,' would be called by Weismann or de Vries 'germinal characters,' while the question of the transmissibility of 'acquired characters' in the sense of Weismann, *i. e.*, somatic characters which are, *ex hypothesi*, not represented in the germ, is not discussed by Montgomery. Weismann and many others use the term 'acquired character' in a peculiar and specific sense, Montgomery with a general and colloquial meaning.

The sixth chapter deals with the 'Transmutation of Species.' It begins with an appreciative account of the part of Lamarck in establishing the theory of evolution, and an interesting discussion of the question of the monophyletic or polyphyletic origin of organisms. The unfortunate prominence of hypothetical ancestors in many evolutionary discussions is excellently set forth in these words: "From the casual inspection of certain writings, and most unfortunately those intended for beginners, one might infer that the *Moneron*, the *Gastræa*, the *Trochozoon*, and the *Bathybius* were more important, if not more real, than the living animals around us."

He concludes that transmutations are definitely directed and that they may be discontinuous, by means of mutations, as de Vries has shown, or continuous, by means of variations. As an illustration of the latter he considers the different geographical races or subspecies of the song sparrow, *Melospiza cinerea*, the geographical as well as morphological intergradations of which indicate that these are not mutants but variants. He concludes, therefore, that 'the mutation theory has not disproved the possibility of perfectly gradual transmutation of species, but has only shown that sometimes transmutation may not be a gradual process.' The author takes an equally broad view with regard to the causes of mutation and variation, holding that 'the factors are neither purely extrinsic, nor purely intrinsic, but a combination of the two.'

The chapter on the 'Parallelism of the Ontogeny and the Phylogeny' contains an extremely interesting and valuable résumé of the 'recapitulation theory.' This is followed by a critical consideration of the whole question, and the conclusion is reached "that the embryology does not furnish any recapitulation of the phylogeny, not even a recapitulation marred at occasional points by secondary change. * * * An analysis of the stages during the life of one individual can in no way present a knowledge of its ancestry; and the method of comparing non-correspondent stages of two species is entirely wrong in principle."

In the chapter on 'Morphological Comparisons' the author argues that in comparison of organisms the whole life cycle should be considered as well as all structural characters, and he strongly insists that only corresponding stages in the ontogeny can properly

be compared, the two stages, which can be most readily determined to be correspondent, being the first and the last. This, together with the greater amount of differentiation found in the adult stage, leads him to the conclusion that end stages in the ontogeny are more important for purposes of comparison, than any other stages. The rigid application of this principle leads him to some very unusual conclusions; *e. g.*, most zoologists will be astonished at the statement that *Sacculina* is not a Crustacean, because in its adult condition it has lost the Crustacean characters which it possessed as a larva. Similarly the statement that the group Chordata is inadmissible because tunicates, Amphioxus and vertebrates are very unlike in the adult condition, though their larvæ show fundamental resemblances, seems to the writer to be out of harmony with the broad and liberal method of comparison advocated in the closing section of the chapter, viz., 'to neglect nothing, to consider every property, kind of individual, every embryonic stage,' etc.

The chapter on the 'Relative Values of Morphological Characters' deals with many interesting questions. The author concludes that types of symmetry—radial, spiral, bilateral—are of little phylogenetic significance, but that metameric segmentation is of great importance. An excellent review of the theories as to the origin of metamerism is followed by the author's view that metamerism has arisen, not from asexual reproduction, but from division of organs, 'Just as one cell gives rise to others by division, so one organ produces others by division.'

In general the conclusion is drawn that the most important of all morphological characters for the purpose of comparison are those which relate to the relative position and connection of parts.

In the tenth chapter the 'Criteria of Racial Advancement' are discussed. Whether an organism is to be regarded as 'high' or 'low,' is, according to the author, dependent entirely upon the length of its line of descent, irrespective of its final complexity or simplicity. This again leads to some very unusual conclusions and causes one to doubt the value of any such definition.

Limits of space have made it necessary to consider only a few of the subjects treated in this work, and the author's conclusions have been stated without presenting the cogent, if not always convincing, arguments by which these conclusions are reached, nevertheless this review will serve to show the great extent and importance of the subjects treated. The author's intimate acquaintance with the great wealth of phenomena and with the extensive literature dealt with in this book, makes it one of particular importance and value to biological students.

E. G. Conklin.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology and Psychology for July contains the following articles: Dr. G. E. Coghill describes the 'Cranial Nerves of *Triton tæniatus*,' comparing the microscopic anatomy and nerve components with *Amblystoma* and the forms described by Drüner. 'Retrograde Degeneraton in the Spinal Nerves,' by S. Walter Ranson. An experimental study of the atrophic changes in both spinal nerves and the cells of the spinal ganglia and spinal cord with special reference to the differences between the typical Wallerian and the retrograde degeneration. 'The Primitive Pores of *Polydon spathula*,' by Herbert D. Kistler, describes with a plate the peculiar sense organs on the bill of the spoon-bill catfish. 'The Reactions of Crayfish to Chemical Stimuli,' by James Carleton Bell. A careful examination of the whole body surface to discover its sensitiveness to various types of chemical solutions. An editorial on abnormal psychology and book notices complete the number.

The *Botanical Gazette* for July contains the following papers: E. C. Jeffrey and M. A. Chrysler discuss the Cretaceous *Pityoxyla*, describing two new species, one from the Middle Cretaceous of Staten Island, the other from Massachusetts. Certain differences from modern pines are pointed out and regarded as ancestral. H. L. Shantz publishes a result of his study of the vegetation of the Mesa region

east of Pikes Peak, discussing the Bouteloua formation as to its structure. Aven Nelson publishes 15 new species of seed plants from the Rocky Mountain region. George J. Peirce gives an account of *Anthoceros* and its Nostoc colonies, showing the fallacy of Prantl's argument that because cavities and hairs do not develop in the usual way except where the colonies are, the liverwort must profit by such an association.

DISCUSSION AND CORRESPONDENCE.

GLACIATION IN THE SONORAN PROVINCE.

TO THE EDITOR OF SCIENCE: In the current number of SCIENCE[1] Dr. Frederick J. H. Merrill directs attention to moraine-like accumulations of debris observed by him at a number of localities in northern Sonora and southern Arizona and New Mexico; of which accumulations part are well known to me—though my provisional interpretations differed from those of Dr. Merrill. The district is too extensive and too little known to warrant broad generalizations or to justify negation of the suggestions offered by so acute an observer as Dr. Merrill; yet future observers may be aided by the alternative suggestions growing out of my own observations in half a dozen journeys in the saddle (with others by rail and stage) through the Sonoran province.

So far as my observations go, the more extensive debris accumulations of the type described by Dr. Merrill (including those in the borrow-pit near Nogales and thence southward to Imuris) are confined to districts of late Mesozoic or Cenozoic vulcanism; while in some cases the accumulations appear to pass both horizontally and vertically upward into undoubted volcanics, much as the tuff beds underlying each table mountain in California grade into more firmly lithified lava sheets. Concordantly, my interpretation of the debris accumulations was that they were originally, and sometimes are now, volcanic tuffs and breccias much like those found further northward along the Pacific coast save that the brecciated structure is more striking than I have seen elsewhere. Frequently the breccias and lava sheets overlie massive blue limestones undoubtedly equivalent to the vast Mesozoic (Cretaceous and Jurassic) limestone series of northeastern Mexico, and probably equivalent to the shale-mixed limestones of the Sierras, especially in southern California; and within a few miles of the borrow-pit south of Nogales (by which I once had occasion to camp for three days while awaiting official documents from Mexico) there are considerable exposures of this limestone, weathered as usual into the peculiar rugose surface—miniature mountain ranges and valleys—found by Hill and others to be characteristic of the Mesozoic limestones in the eastern Sierra Madre. The calcareous deposits are seen in places to rest (and probably everywhere lie) unconformably on granites, which in western Sonora and southwestern Arizona are of wide extent; yet neither on the limestone nor on the granitic terranes have I observed such debris accumulations as those so characteristic of the Imuris or Opodepe valley. Certain of the accumulations in this valley seemed to me well worthy of critical study as breccias primarily volcanic though accumulated in part by concurrent aqueous agencies, and recording in themselves a peculiarly complex volcanic history; for in several sections there are imbedded in the clay-like matrix angular boulders yards in dimensions, sometimes containing included boulder-like masses feet across, themselves made up of brecciated constituents inches or less in diameter. A part of the heterogeneous accumulations both in Imuris Valley and elsewhere were interpreted by me as rearranged breccias transported to limited distances and redeposited by sheetfloods or other freshets during the rather remote periods in which the lava sheets and tuff beds were newly exposed to surface erosion. In this connection it is to be noted that the province in question is the type region for sheetflooding, and that both the lower slopes of the sierras and the intervening plains are shaped by this agency; and also that sheetflood deposits are normally heterogeneous and ill-assorted accumulations of coarse and fine material, seldom perceptibly stratified or graded from coarse to fine either horizontally or vertically in the single section.

[1] Volume XXIV., pp. 116–118.

My interpretations were influenced by what seemed to me negative evidence both in topographic forms and in surficial materials throughout the lower ranges and intervening plains of western Sonora and southern Arizona. I have ridden over and camped on the country between Arivaca and Sopori (mentioned by Dr. Merrill), where the erosion forms assumed by the widespread tuff beds often simulate morainal deposits in general landscape effects, without finding indications of glacial agency either in deposits or in minute topography; while over the more elevated remnants of eroded ranges and among the lower slopes of the more rugged sierras most of the topographic forms impressed me as not merely water-cut but carved in that peculiarly acute fashion characteristic of the margins of sheetflood plains. Some of these plains are indeed diversified, especially toward the mountain margins, with both basin-shape depressions and debris-heaps, the latter frequently near the valleyward extremities of the former—the basins having been originally places of concentrated flow of the (generally dwindling) sheetfloods, and the debris-heaps the delta-like accumulations by which the localized corrosion was originally checked; though the heaps usually outlast the basins, especially when composed largely of obdurate rock-fragments, and form a type or genetic class of those natural mounds which are of late attracting much attention. The region is one of distinctively significant geomorphy; for it is not only the type district of sheetflood erosion, but comprises an extensive area of retrogressive carving due to a southwestward tilting—an area in which the general divides seldom coincide with the axes of the sierras but run far out on the low-lying plains between, circumscribing the head slopes of waterways (of which Rio Seco and Rio Bacuache are types) that have retrogressed northeastward entirely through the ranges in which they originally headed. Several examples of this remarkable retrogression were surveyed and mapped in detail by Willard D. Johnson in connection with that expedition which yielded his notable map of Seriland published in the *National Geographic Magazine* and also in the Seventeenth Annual Report of the Bureau of American Ethnology; unfortunately, these surveys have not yet been published. During this same expedition Mr. Johnson worked over most of the surface and ascended most of the crests along the valleys lying next west of that of the Imuris; but neither he nor I noted ice-shaped topography anywhere in the region. Of course, any negative inference is worth far less than the positive inductions of a geologist familiar, like Doctor Merrill, with such glacial topography and deposits as those of northeastern United States; yet it is worthy of consideration pending more extended surveys than have thus far been found practicable in the Sonoran province.

W J McGee.
Saint Louis Public Museum.

The Earthquake and Professor Larkin.

In the *Open Court* for July, 1906, is a remarkable account of 'The Great San Francisco Earthquake,' from the pen of Edgar L. Larkin, of the 'Lowe Observatory on Echo Mountain,' otherwise professor of astronomy and geology in the University of the Sunday Supplement.

Professor Larkin came to San Francisco immediately after the earthquake of April 18. In a day or two he was able to discover a number of things which had escaped the notice of the local geologists, Lawson, Branner, Gilbert, Campbell, Davidson and others, constituting the official State Earthquake Commission.

Professor Larkin says: "One of my objects in leaving the peace and quiet in the observatory on the mountain, to make a five-hundred-mile journey to the stricken city, was to study the action of the earthquake in the great cemeteries. The fallen columns write the history of the convulsion in stone." To his surprise he found that "the half dead made their homes with the dead. Weak and wan girls played with the marble angels. * * * One desolate family found shelter in a beautiful sepulchre while the sufferers rested their heads on lowly graves." This was the more remarkable, for, as Jerome Hart suggests in the same connection, there is in California a

deep-rooted superstition that it is unlucky to be killed by a falling tomb during an earthquake. Yet in this stress, superstitions fell away like dead leaves and the people slept through the long night with fallen angels among beds of violets.

And this stress was, indeed, terrible. "The Pacific," observes Professor Larkin, "was startled with the onrush of the terror-stricken. * * * The glorious poppies of California vied with each other in striving to attract attention away from the appalling scene * * * but in vain."

"One of the most vivid, awe-inspiring and impressive facts * * * is this: the people in the city did not hear subterranean sounds! But the awful reason why was because of the terrible roar roundabout, from seething flames, tumbling walls, the crashing of glass and the hissing of sliding, rasping miles of wire. The literature of earthquakes does not present a more striking and startling fact, for the roaring of the city all aflame was louder than the thundering in caves of gloom below." Other observers failed to note that the city was already roaring with 'seething flames' in the forty-seven seconds through which the shock lasted.

It is interesting to see how accurately the lower animals predicted the earthquake. In San José, eighteen minutes before the shock, "two mares with young colts were running and whinnying * * * in alarm as though dogs were after them. Dogs were there, but they, too, gave unusual warning of danger. * * * I have," observes Professor Larkin, "a mass of facts that can not be mentioned in less space than a good-sized book." It was in San José, also, three days before the earthquake, so I am informed, that a cat was heard to utter three sounds sharp and high, these followed by a hiss as of escaping steam. A dog was present and appeared also agitated. It was noticed that the dog's nose was cold, while the tail of the cat was rigidly erected. At Petaluma, it is said, a cock (white Leghorn) crowed three times, on the morning before the shock.

"Many fish," continues Professor Larkin, "were killed along the coast and as far south as Los Angeles. And fish taken from the sea opposite Los Angeles had such a strong odor of sulphur that they could not be eaten." This is the more remarkable as Los Angeles is five hundred miles from the point where the earthquake rift leaves the sea. But it may be noted also that the shock went twice around the world, and that there were fishes in the market of Tokyo on April 18 that had also such a strong odor that they could not be eaten. It is not stated whether the odor was that of sulphur, a matter to be investigated. In or near London, two months later, an odor of sulphur, or sulphuretted hydrogen, was detected in certain suddenly opened eggs which had been laid on or near the eighteenth of April. This is given on the authority of a distinguished actor lately returned from a tour in the provinces.

Another 'remarkable' fact is this: "The immense bay of San Francisco is filled and emptied by tides. The volume of water is enormous, and if forced through the Golden Gate, the current would be rapid, indeed. No such velocity exists, hence there may be an underground connection with the ocean." It is a singular fact that none of the local geologists have ever seen San Francisco Bay emptied. Still it might happen under cover of dense fog. In any case no great stress should be laid on this failure to observe, which has at most merely negative value.

Professor Larkin notices that although no sun spots greater than twice the size of the earth were visible at that time, yet on April 18 the sun, moon, Mercury, Venus, Mars, Jupiter and Saturn were massed within five hours twenty-eight minutes of right ascension. But, again, as the earthquake occurred at five o'clock thirteen minutes, this can not be held to prove anything; the seventeen minutes of discrepancy can not be overlooked. Moreover, Professor Larkin tells us the earth was at the time only 618,000 miles out of her usual orbit. This is not much for a globe which travels three hundred millions of miles a year and so is accustomed to deal with large figures.

The display of blue flames before the onslaught of the red ones, and their final yellow sequences was very remarkable. "The appear-

ance of blue lights," says Professor Larkin, "was over a wider area than at first thought. At Petaluma * * * blue flames eighteen inches in height played over a wide expanse of marsh land." Before the earthquake only "a flickering ominous haze was seen playing above the ground." "A dark funnel-shaped mass was seen in Fourth Street, San Francisco, suspended in the air, and it was illuminated by scintillating lights, like fire-flies." "Blue flames were seen hovering over the bases of foothills in western San Francisco." In San José, on the street called the Alameda, looking eastward, at the time of the shock the whole street was seen "ablaze with fire, it being of a beautiful rainbow color but faint. This, no doubt," observes Professor Larkin, "was an electrical display, for had gas been on fire all along the street the houses would have been ignited. And letters from a point north of San Francisco describe blue lights as flickering like an aurora over a wide area of marsh land with a troubled surface of adjoining water. And can it be that the giant Electricity took part in the vast seismic turbulence? * * * The writer scarcely knows which one of the multitude of theories regarding the cause of earthquakes to adopt."

Later Professor Larkin grows more confident and asserts that "the San Francisco earthquake was due to a readjustment of the edge of the layers once torn apart when the earth was young. * * * It appears that two faults were involved. * * * I do not wish to assert that the earth's charge of electricity helped in the havoc, but believe that it did. That giant is able to do any vast work."

No wonder that in Professor Larkin's mind 'great questions arise.' "Did man appear on earth before his dwelling was ready? Does nature care whether man exists? It is asserted that she has slain thirteen million human beings by convulsive force alone within the historic period."

'Swing low, Sweet Chariot,' sings Professor Larkin, with cheerful relevance. And, indeed, when we stop to think of it, why not?

D. S. J.

SPECIAL ARTICLES.

TIME VARIATION OF THE INITIAL NUCLEATION OF WET DUST-FREE AIR.

In the further development of the investigation[1] on the time variations of the efficient colloidal nucleation in filtered air, I find results of the same character as those already discussed; but the dependence of the nucleation on the fluctuations of the barometer shows itself even more obstrusively than before. The minima of atmospheric pressure coincide with maxima of the larger colloidal nucleation and therefore (by inference but not necessarily) with minima of ionization of the dust-free air, both in the daily and in the weekly periods of observations. Maximum pressure would correspond to maximum ionization as if the radiant energy originated in the compression of the atmosphere, or were dependent on the mass of the atmosphere bearing on a given place. This would, if finally substantiated, be an important result, but no more so than the correlative result that minimum pressure and maximum of the initial colloidal nucleation of dust-free air go together. The bearing of this on 'adsorption' of atmospheric ionization will be stated presently.

At the same time since the change of absolute temperature, t, due to sudden expansion equivalent to a drop δp at a barometric pressure p and vapor pressure π may be written

$$t_2/t_1 = (1 - \delta p/(p - \pi))^{(k-c)/c}$$

the correction for the changes of the barometer are in the same sense as the observed changes in nucleation. These corrections are found by varying the numerator of $\delta p/(p - \pi)$ and observing the effect on the angular diameter of the corona. While I see no room for error, it must nevertheless be acknowledged that the present method of small exhaustion (though possibly more sensitive) is not as straightforward as the method mentioned in my address where no variation could be detected, the terminal corona remaining unchanged.

At the present stage of investigation, therefore, the need of any cosmical radiation has ceased to be obvious and should be abandoned,

[1] SCIENCE, XXIII., p. 952, 1906.

and the results, if they are not due to some obscure barometric effect which has escaped me, are most directly referable to changes of pressure within the atmosphere, the number of the colloidal nuclei specified being greatest when the pressure is least. This view, moreover, would not be incompatible with the persistence of terminal coronas referred to above. It is also compatible with the following. If among the initial nuclei entrapped (which lie very near the region of ions) the ions actually preponderate, the observations would then mean that increased ionization accompanies the falling barometer. Under these conditions, however, radioactive emanation is known to be withdrawn from the stagnant air within the porous ground and the earth generally. Hence the data could now be interpreted as evidence of the necessary fluctuation of such emanation with the barometer.

I may add that I have since installed a second apparatus side by side with the first and that the data, though differing in their details, show the same dependence on the barometer in their broader time variations.

CARL BARUS.

BROWN UNIVERSITY.

USE OF THE TERM PERMIAN IN AMERICAN GEOLOGY.

FOR over fifty years the Permian question has been one of the moot problems of American geology. Of late it has been quite generally agreed that the title should not, at least, be applied to any American formation having the taxonomic rank of period or system, coordinate with such terms as Carboniferous or Cretaceous.

Division is now upon the point whether the so-called Permian section as represented in Kansas should be called by Murchison's title and given the rank of series, or whether the name should not be abandoned altogether as a designation for any American formation.

Upon this point Professor Prosser has recently made a summary of opinion. Among the statements is this: "There is still a difference of opinion among American geologists in regard to the correlation of the Upper Paleozoic formations of Kansas with the Russian Permian. The *Journal of Geology*, published in 1898 'A Symposium on the Classification and Nomenclature of Geologic Time-divisions,' in which Dr. Williston, Professor Calvin and Dr. Keyes reported adversely both as to the identification of the Permian in Kansas and as to its recognition as a period coordinate with the Carboniferous or Devonian; while Dr. William B. Clark stated that for the later divisions of the Paleozoic he should employ the chronologic terms Carboniferous and Permian."

Professor Prosser further observes: "No one has, perhaps, insisted as strenuously as Dr. Keyes that the name Permian should be dropped from American geology. In 1897 he attended the sessions of the International Congress of Geologists at St. Petersburg and participated in the excursions to the Carboniferous and typical Permian of Russia. Later he prepared a paper on the 'American Homotaxial Equivalents of the Original Permian,' and quotations from this can not be regarded as from one favoring the retention of the name 'Permian.'"

It is quite manifest that Professor Prosser has objected to my usage of the title of 'Oklahoman series' for the so-called Lower Permian of Kansas. My repeated use of the term Oklahoman has been made advisedly. It had been thought quite desirable to have the title of this section distinctive, irrespective of what age might be eventually assigned to it.

The recent discovery in New Mexico and Texas of a great formation (Guadalupan series) having a thickness of more than 2,500 feet, that appears to be intercalated between the Carboniferous Red Beds (Cimarronian series) and the equivalent of the Oklahoman series, indicates that the Kansas section of the latest part of the Paleozoic is not nearly so complete as it was thought to be. It also suggests that in Kansas there are no formations below the Red Beds that can be considered of late Carboniferous age, or that might be paralleled with the Permian at all. This, it would seem, would almost put an end to the contention for a Permian age of such Kansas beds as the Neosho, Chase and Marion formations.

Tschernychew, who is one of the best au-

COMPARATIVE TABLE OF CARBONIFEROUS FORMATIONS.

	Age.	Mississippi Province.	Southwestern Province.	Ural Province.
Carboniferous	Late	Cimarronian Wanting?	Cimarronian Guadalupan	Tataran (Upper P.) L. and M. Permian
	Mid	Oklahoman Missourian Des Moines Arkansan	Maderan Manzanan Wanting Ladronesian	Artinsk Upper Carboniferous } Middle Carboniferous
	Early	Mississippian	Socorran	Lower Carboniferous

thorities on the Russian Permian formation, and who has visited the Kansas localities, places the Marion beds, which are immediately beneath the Red Beds, on a level with the Russian Artinsk terrane. Personal observations in both fields point strongly to the correctness of this correlation. The Artinsk formation is older than any terrane of the original Permian sequence. Girty, who quite recently has also rather critically examined the Guadalupan section in Trans-Pecos Texas, concludes that if this fauna is Permian then certainly that of Kansas is not.

It would seem then that our conceptions of the American Permian formations must undergo very radical changes. Our scheme of comparison with the original Permian section of Russia would then be about as in the table given above.

Charles R. Keyes.
New Mexico State School of Mines.

QUOTATIONS.

PROFESSOR M'KENDRICK AND THE PROGRESS OF PHYSIOLOGY.

The valedictory address delivered by Professor J. G. M'Kendrick, at the close of the summer session of the University of Glasgow, on the occasion of his resignation of the professorship of physiology, provides a striking account of the progress of physiological science during the past thirty years. In 1861, when Professor M'Kendrick attended a course of lectures at Aberdeen, there was no attempt at demonstration except by diagrams and a few microscopes on a side-table. There were no experiments, and the only instrument displayed was a sphygmograph. But a little later Goodsir, of Edinburgh, brought from continental schools of physiology to the University of Edinburgh such instruments as myographs, kymographs, electrical appliances and other apparatus, and the teaching of practical physiology was soon firmly established under Argyll Robertson. Professor M'Kendrick himself installed similar teaching in the University of Glasgow in 1876, the date of his appointment to the chair of physiology. The requirements of modern physiological teaching are shown by a statement in the address that while Professor M'Kendrick has worked and taught for thirty years in five rooms, twenty-five are apportioned to physiological work in the new buildings. Reviewing the progress of physiology, Professor M'Kendrick detailed the advances made in histology and expressed the doubt whether much more progress can be expected. Graphic methods have been elaborated during the same period, and the action of electrical stimuli on muscle and nerve elaborately worked out. The study of the functions of living isolated organs, modern vivisectional methods, our knowledge of the nerve paths in the central nervous system, and the subject of internal secretions, are all among the triumphs of physiological science during the past thirty years, and were each passed in review. In conclusion, Professor M'Kendrick indicated physiological chemistry as the direction in which progress will be made during the next few decades.—*Nature.*

ASTRONOMICAL NOTES.

THE SYSTEM OF CASTOR.

Castor was one of the first close double stars known and one of those which led Sir William Herschel to the belief that such stars form real binary systems.

Belopolsky discovered, in 1896, that the fainter, preceding component of Castor, a_1 Geminorum, was a spectroscopic binary, having a period of about 2.9 days. In the June number of the *Astrophysical Journal* Dr. Heber D. Curtis gives an elaborate investigation of this system, which has been made at the Lick Observatory. The refined results now obtained amply confirm the general conclusions of Belopolsky. The final period found at the Lick Observatory is 2.928285 days.

Curtis has also discovered that the brighter, following component, a_2, is a spectroscopic binary having a period of 9.218816 days. Ignoring the faint and distant companion which also exists, Castor thus becomes one of the most wonderful stellar systems known. While the elements of the spectroscopic systems thus revealed are well known, less can be said of the visual components of Castor themselves. These have been observed since the time of the elder Herschel, but their motion is slow, and Burnham considers that the problem of finding the elements is indeterminate at present, and likely to remain so for a century. Different determinations of the period have varied from little more than 200 years to more than 1,000 years.

An interesting phase of this quadruple system lies in the fact that while the orbits of the components of a_1 are nearly circular, those of a_2 are very elliptical. The change in the mutual attractions of the components of so eccentric a system as that of a_2 must be great, and in other cases this has been found to be associated with variability in the light. On this account Mr. Curtis made some photometric determinations of the light of a_2, but no proof of variability was found. This need not cause surprise, however, since the physical condition of a star must determine whether such increased attractions would show themselves in a change of luminosity.

REFLECTING TELESCOPES OF SHORT FOCUS.

H. C. VOGEL, director of the Astrophysical Observatory at Potsdam, calls attention, in a communication to the *Kgl. Akademie der Wissenschaften,* Berlin, to the possibilities of short-focus reflecting telescopes. A translation of this article appears in the June number of the *Astrophysical Journal.* The competition, which has always existed between reflecting and refracting telescopes, is still keen, but at the present moment the reflector seems to occupy the center of the stage. Each form of instrument has certain limitations which are inherent, and each has distinct advantages over the other for certain purposes. A good reflector brings all the colors perfectly to the same focus, while the best refractor is not really achromatic. Also, the loss of light by reflection is in general much less than that by absorption. The result is that for nearly all objects the action of a reflector is much more rapid than that of a refractor of equal size. The circles of chromatic aberration may also cause a distortion of the form of the image of certain objects, such as the Orion nebula, when photographed with a refractor. On the other hand, the field of good definition is very small, in the case of the reflector. The images are perfect only at the center, and sufficiently good for use only over a region half a degree in diameter, or even less. Certain forms of the refractor, however, give good definition over a field ten, or even twenty, degrees in diameter. It is evident, therefore, that where a large field is required, as in making a photographic map of the sky, the refractor must be used. Over a small field, however, the reflector can photograph objects of such extreme faintness that they lie quite beyond the reach of the largest refractor.

Schwarzschild has shown that an extension of the field of the reflecting telescope may be obtained by the use of a second mirror. It is possible that the diameter of the field may be extended to several degrees in this way. Practically, this has not yet been done, but its successful accomplishment would mark an epoch in the history of the telescope. The power of the reflector evidently increases with the decrease of its focal length. Schaeberle has recently made some experiments to show how far this can be carried. He constructed a thirteen-inch reflector of twenty-inch focus, with which he was able to photograph stars of the seventeenth magnitude with an exposure

of only two minutes. The scale of the photographs, however, is so small that great magnification is necessary, and many details must be obscured, although the definition at the center of the small plates used appears to be good. There must be some practical limit to the decrease in the ratio of focus to aperture, and Schaeberle has apparently been working near, if not beyond it. Vogel gives some wonderfully good results obtained with a Schmidt mirror, using an aperture of 24 cm. which makes the ratio of aperture to focus 1:3.86. With the full aperture of 41 cm. and an exposure of ten minutes, many more stars were photographed than are visible in the great Lick refractor of more than 91 cm. aperture.

SOME CONSIDERATIONS REGARDING THE NUMBER OF THE STARS.

THE above title is the subject of a paper in the May number of the *Monthly Notices* of the Royal Astronomical Society. It is written by Miss Winnifred Gibson, B.Sc., and communicated by Professor Karl Pearson, F.R.S.

The problem is one of the deepest interest, but its solution is rendered difficult, if not impossible at the present time, by lack of fundamental data. The distribution of the stars would be readily determinable, if the parallaxes of a sufficient number had been determined. After confessing the lack of such materials, Miss Gibson, nevertheless, proceeds to an elaborate discussion of such data as exist. She arrives at the conclusion, for the brighter stars, that 'There is no sensible relation between magnitude and parallax.' The chief trouble with this conclusion is that it is derived from entirely inadequate data. The stars, whose parallaxes are taken into consideration, are of the ninth magnitude, and brighter. Of such stars there are in the sky about 150,000. For obtaining any law of relation between the magnitudes and distances of all these stars, the parallaxes of 72 stars, about one in 2,000, are available. Neither is there evidence that this small number is distributed by chance among the stars, nor that the parallax in many cases is sufficiently exact for purposes of discussion. Results based upon such meager data must have little or no value, however skillful and elaborate the treatment may be. Not much more can be said of that part of the discussion relating to proper motions and colors.

The latter part of the paper is concerned with the relation of magnitudes and frequencies, and gives results which are in substantial agreement with those of Professor E. C. Pickering, recently published, although Miss Gibson prefers a somewhat different formula. The author confines her attention to the brighter stars. The problem becomes at once more interesting and more difficult as it is extended to the fainter stars. Miss Gibson complicates the problem by assuming that magnitude is largely a physiological phenomenon, and hence that 'It is hardly conceivable that a scale of pure magnitudes could have any meaning in physical nature.' This is quite erroneous, since the determination of magnitudes, whether by visual or photographic methods, is simply the determination of the intensity of certain radiations, which surely have an objective reality based on physical conditions.

SOLON I. BAILEY.
HARVARD COLLEGE OBSERVATORY.

RECENT VERTEBRATE PALEONTOLOGY.

FROM the Brazilian Coal Commission, through Dr. I. C. White, state geologist of West Virginia, the American Museum of Natural History has just received the gift of a number of natural casts of a small Permian reptile closely related to the *Mesosaurus* of South Africa. These Brazilian remains have been carefully studied by J. H. McGregor for a memoir which will be published by the commission, and which for the first time gives us a complete knowledge of the anatomy of this extremely ancient reptile. It is related to the genus *Stereosternum* Cope, also from Brazil, which Baur made the type of the order Proganosauria, under the impression that these were very ancient and generalized reptiles. It is true they are very ancient but are not generalized, they are rather already considerably specialized for aquatic life, as shown in Dr. McGregor's restoration of the skeleton and

of the probable external form of this animal.

In this connection Dr. R. Broom, of Victoria College, Stellenbosch, South Africa, writes, under date of July 3: "An interesting point to remember is the horizon of *Mesosaurus* in South Africa. It is in the very lowest of the Permian beds—beds which the geologists are inclined to regard as Carboniferous, though I hold it is Permian. It is 5,000–6,000 feet below the Upper Permian beds, and perhaps the oldest true reptile known. *Mesosaurus* has nothing to do with the Plesiosauria."

H. F. O.

AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK, July 30, 1906.

THE PURE FOOD BILL.[1]

An Act preventing the manufacture, sale or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines and liquors, and for regulating the foods, drugs, medicines and liquors, and for regulating traffic therein, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled:

[Public—No. 384.]

SEC. 1. That it shall be unlawful for any person to manufacture within any territory or the District of Columbia any article of food or drug which is adulterated or misbranded, within the meaning of this act; and any person who shall violate any of the provisions of this section shall be guilty of a misdemeanor, and for each offense shall, upon conviction thereof, be fined not to exceed $500 or shall be sentenced to one year's imprisonment, or both such fine and imprisonment, in the discretion of the court, and for each subsequent offense and conviction thereof shall be fined not less than $1,000 or sentenced to one year's imprisonment, or both such fine and imprisonment, in the discretion of the court.

SEC. 2. That the introduction into any state or territory or the District of Columbia from any other state or territory or the District of Columbia, or from any foreign country, or shipment to any foreign country of any article of food or drug which is adulterated or misbranded, within the meaning of this act, is hereby prohibited; and any person who shall ship or deliver for shipment from any state or territory or the District of Columbia to any other state or territory or the District of Columbia, or to a foreign country, or who shall receive in any state or territory or the District of Columbia from any other state or territory or the District of Columbia, or foreign country, and having so received, shall deliver, in original unbroken packages, for pay or otherwise, or offer to deliver to any other person, any such article so adulterated or misbranded within the meaning of this act, or any person who shall sell or offer for sale in the District of Columbia or the territories of the United States any such adulterated or misbranded foods or drugs, or export or offer to export the same to any foreign country, shall be guilty of a misdemeanor, and for such offense be fined not exceeding two hundred dollars for the first offense, and upon conviction for each subsequent offense not exceeding three hundred dollars or be imprisoned not exceeding one year, or both, in the discretion of the court: *Provided,* That no article shall be deemed misbranded or adulterated within the provisions of this act when intended for export to any foreign country and prepared or packed according to the specifications or direction of the foreign purchaser when no substance is used in the preparation or packing thereof in conflict with the laws of the foreign country, but this proviso shall not exempt said article from the operation of any of the other provisions of this act.

SEC. 3. That the Secretary of the Treasury, the Secretary of Agriculture, and the Secretary of Commerce and Labor shall make uniform rules and regulations for carrying out the provisions of this act, including the collection and examination of specimens of foods and drugs manufactured or offered for sale in the District of Columbia, or in any territory of the United States, or which shall be offered for sale in unbroken packages in any state other than that in which they shall have been respectively manufactured or produced, or which shall be received from any foreign

[1] Text of the bill adopted at the last session of the congress, approved by the president on June 30.

country, or intended for shipment to any foreign country, or which may be submitted for examination by the chief health, food, or drug officer of any state, territory, or the District of Columbia, or at any domestic or foreign port through which such product is offered for interstate commerce or for export or import between the United States and any foreign port or country.

Sec. 4. That the examinations of specimens of foods and drugs shall be made in the Bureau of Chemistry of the Department of Agriculture, or under the direction and supervision of such bureau, for the purpose of determining from such examinations whether such articles are adulterated or misbranded within the meaning of this act; and if it shall appear from any such examination that any of such specimens is adulterated or misbranded within the meaning of this act, the Secretary of Agriculture shall cause notice thereof to be given to the party from whom such sample was obtained. Any party so notified shall be given an opportunity to be heard, under such rules and regulations as may be prescribed as aforesaid, and if it appears that any of the provisions of this act have been violated by such party, then the Secretary of Agriculture shall at once certify the facts to the proper United States district attorney, with a copy of the results of the analysis or the examination of such article duly authenticated by the analyst or officer making such examination, under the oath of such officer. After judgment of the court, notice shall be given by publication in such manner as may be prescribed by the rules and regulations aforesaid.

Sec. 5. That it shall be the duty of each district attorney to whom the Secretary of Agriculture shall report any violation of this act, or to whom any health or food or drug officer or agent of any state, territory, or the District of Columbia shall present satisfactory evidence of any such violation, to cause appropriate proceedings to be commenced and prosecuted in the proper courts of the United States, without delay, for the enforcement of the penalties as in such case herein provided.

Sec. 6. That the term 'drug,' as used in this act, shall include all medicines and preparations recognized in the United States Pharmacopeia or National Formulary for internal or external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of either man or other animals. The term 'food,' as used herein, shall include all articles used for food, drink, confectionery, or condiment by man or other animals, whether simple, mixed, or compound.

Sec. 7. That for the purposes of this act an article shall be deemed to be adulterated—

In case of drugs:

First. If, when a drug is sold under or by a name recognized in the United States Pharmacopeia or National Formulary, it differs from the standard of strength, quality, or purity, as determined by the test laid down in the United States Pharmacopeia or National Formulary official at the time of investigation: *Provided,* That no drug defined in the United States Pharmacopeia or National Formulary shall be deemed to be adulterated under this provision if the standard of strength, quality, or purity be plainly stated upon the bottle, box, or other container thereof, although the standard may differ from that determined by the test laid down in the United States Pharmacopeia or National Formulary.

Second. If its strength or purity fall below the professed standard or quality under which it is sold.

In the case of confectionery:

If it contains terra alba, barytes, talc, chrome yellow, or other mineral substance or poisonous color or flavor, or other ingredient deleterious or detrimental to health, or any vinous, malt, or spirituous liquor or compound or narcotic drug.

In the case of food:

First. If any substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength.

Second. If any substance has been substituted wholly or in part for the article.

Third. If any valuable constituent of the article has been wholly or in part abstracted.

Fourth. If it be mixed, colored, powdered, coated, or stained in a manner whereby damage or inferiority is concealed.

Fifth. If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health: *Provided,* That when in the preparation of food products for shipment they are preserved by any external application applied in such manner that the preservative is necessarily removed mechanically, or by maceration in water, or otherwise, and directions for the removal of said preservative shall be printed on the covering or the package, the provisions of this act shall be construed as applying only when said products are ready for consumption.

Sixth. If it consists in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not, or if it is the product of a diseased animal, or one that has died otherwise than by slaughter.

SEC. 8. That the term 'misbranded,' as used herein, shall apply to all drugs, or articles of food, or articles which enter into the composition of food, the package or label of which shall bear any statement, design, or device regarding such article, or the ingredients or substances contained therein which shall be false or misleading in any particular, and to any food or drug product which is falsely branded as to the state, territory, or country in which it is manufactured or produced.

That for the purposes of this act an article shall also be deemed to be misbranded:

In case of drugs:

First. If it be an imitation of or offered for sale under the name of another article.

Second. If the contents of the package as originally put up shall have been removed, in whole or in part, and other contents shall have been placed in such package, or if the package fail to bear a statement on the label of the quantity or proportion of any alcohol, morphin, opium, cocain, heroin, alpha or beta eucain, chloroform, cannabis indica, chloral hydrate, or acetanilid, or any derivative or preparation of any such substances contained therein.

In the case of food:

First. If it be an imitation of or offered for sale under the distinctive name of another article.

Second. If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed in whole or in part and other contents shall have been placed in such package, or if it fail to bear a statement on the label of the quantity or proportion of any morphin, opium, cocain, heroin, alpha or beta eucain, chloroform, cannabis indica, chloral hydrate, or acetanilid, or any derivative or preparation of any such substances contained therein.

Third. If in package form and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

Fourth. If the package containing it or its label shall bear any statement, design, or device regarding the ingredients or the substances contained therein, which statement, design, or device shall be false or misleading in any particular: *Provided,* That an article of food which does not contain any added poisonous or deleterious ingredients shall not be deemed to be adulterated or misbranded in the following cases:

First. In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food, under their own distinctive names, and not an imitation of or offered for sale under the distinctive name of another article, if the name be accompanied on the same label or brand with a statement of the place where said article has been manufactured or produced.

Second. In the case of articles labeled, branded, or tagged so as to plainly indicate that they are compounds, imitations, or blends, and the word 'compound,' 'imitation,' or 'blend,' as the case may be, is plainly stated on the package in which it is offered for sale: *Provided,* That the term 'blend' as used herein shall be construed to mean a mixture of like substances, not excluding harmless coloring or flavoring ingredients used for the purpose of coloring and flavoring only: and *Provided, further,* That nothing in this act shall

be construed as requiring or compelling proprietors or manufacturers of proprietary foods which contain no unwholesome added ingredients to disclose their trade formulas, except in so far as the provisions of this act may require to secure freedom from adulteration or misbranding.

Sec. 9. That no dealer shall be prosecuted under the provisions of this act when he can establish a guaranty signed by the wholesaler, jobber, manufacturer or other party residing in the United States, from whom he purchases such articles, to the effect that the same is not adulterated or misbranded within the meaning of this act, designating it. Said guaranty, to afford protection, shall contain the name and address of the party or parties making the sale of such articles to such dealer, and in such case said party or parties shall be amenable to the prosecution, fines and other penalties which would attach, in due course, to the dealer under the provisions of this act.

Sec. 10. That any article of food, drug or liquor that is adulterated or misbranded within the meaning of this act, and is being transported from one state, territory, district or insular possession to another for sale, or, having been transported, remains unloaded, unsold or in original unbroken packages, or if it be sold or offered for sale in the District of Columbia or the territories or insular possessions of the United States, or if it be imported from a foreign country for sale, or if it is intended for export to a foreign country, shall be liable to be proceeded against in any district court of the United States within the district where the same is found, and seized for confiscation by a process of libel for condemnation. And if such article is condemned as being adulterated or misbranded, or of a poisonous or deleterious character, within the meaning of this act, the same shall be disposed of by destruction or sale, as the said court may direct, and the proceeds thereof, if sold, less the legal costs and charges, shall be paid into the treasury of the United States, but such goods shall not be sold in any jurisdiction contrary to the provisions of this act or the laws of that jurisdiction: *Provided, however,* That upon the payment of the costs of such libel proceedings and the execution and delivery of a good and sufficient bond to the effect that such articles shall not be sold or otherwise disposed of contrary to the provisions of this act or the laws of any state, territory, district or insular possession, the court may by order direct that such articles be delivered to the owner thereof. The proceedings of such libel cases shall conform, as near as may be, to the proceedings in admiralty, except that either party may demand trial by jury of any issue of fact joined in any such case, and all such proceedings shall be at the suit of and in the name of the United States.

Sec. 11. The Secretary of the Treasury shall deliver to the Secretary of Agriculture, upon his request, from time to time, samples of foods and drugs which are being imported into the United States or offered for import, giving notice thereof to the owner or consignee, who may appear before the Secretary of Agriculture and have the right to introduce testimony, and if it appear from the examination of such samples that any article of food or drug offered to be imported into the United States is adulterated or misbranded within the meaning of this act, or is otherwise dangerous to the health of the people of the United States, or is of a kind forbidden entry into, or forbidden to be sold or restricted in sale in the country in which it is made or from which it is exported, or is otherwise falsely labeled in any respect, the said article shall be refused admission, and the Secretary of the Treasury shall refuse delivery to the consignee and shall cause the destruction of any goods refused delivery which shall not be exported by the consignee within three months from the date of notice of such refusal under such regulations as the Secretary of the Treasury may prescribe: *Provided,* That the Secretary of the Treasury may deliver to the consignee such goods pending examination and decision in the matter on execution of a penal bond for the amount of the full invoice value of such goods, together with the duty thereon, and on refusal to return such goods for any cause to the custody of the Secretary of the Treasury, when demanded, for the purpose of excluding them from the country, or for any other pur-

pose, said consignee shall forfeit the full amount of the bond: and *Provided, further,* That all charges for storage, cartage and labor on goods which are refused admission or delivery shall be paid by the owner or consignee, and in default of such payment shall constitute a lien against any future importation made by such owner or consignee.

SEC. 12. That the term 'territory,' as used in this act, shall include the insular possessions of the United States. The word 'person,' as used in this act, shall be construed to import both the plural and the singular, as the case demands, and shall include corporations, companies, societies and associations. When construing and enforcing the provisions of this Act, the act, omission or failure of any officer, agent or other person acting for or employed by any corporation, company, society or association, within the scope of his employment or office, shall in every case be also deemed to be the act, omission or failure of such corporation, company, society or association as well as that of the person.

SEC. 13. That this act shall be in force and effect from and after the first day of January, 1907.

SCIENTIFIC NOTES AND NEWS.

SIR DAVID GILL, H. M. astronomer at the Cape of Good Hope, will succeed Dr. E. Ray Lankester, director of the British Museum of Natural History, as president of the British Association for the Advancement of Science.

A KNIGHTHOOD has been conferred on Dr. W. H. Perkin, F.R.S., the jubilee of whose discovery of the aniline dye mauve has recently been celebrated.

SIR JAMES DEWAR, Jacksonian professor of experimental philosophy at Cambridge University and Fullerian professor of chemistry at the Royal Institution, has received the Matteucci medal of the Italian Society of Sciences.

DR. A. E. DOLBEAR, since 1874 professor of physics at Tufts College, has retired from active service under the provisions of the Carnegie Foundation.

DR. A. G. RUTHVEN has been appointed curator of the Museum of the University of Michigan. He is spending the summer in Texas, New Mexico and Arizona, collecting reptiles and studying their field relations for the American Museum of Natural History.

DR. ALBERT ERNEST JENKS, formerly the chief of the Ethnological Survey of the Philippine Islands, has been engaged in the cataloguing of the Philippine ethnological collection, purchased by the American Museum of Natural History at the St. Louis Exposition.

WE learn from the London *Times* that at a meeting of the master and fellows of Christ's College, Cambridge, held on July 20, Mr. Francis Darwin was elected honorary fellow, and Dr. G. H. F. Nuttall, F.R.S., fellow of the society. Mr. Darwin is foreign secretary of the Royal Society. He was educated at Trinity College and for many years was reader in botany in the university and fellow of Christ's. Dr. Nuttall, who has held teaching posts at Johns Hopkins University and at the University of Berlin, is now reader in hygiene at Cambridge. He is the chief editor of the *Journal of Hygiene.*

DR. A. L. CRAMPTON, of Maryland, has been made chief of a division of the Bureau of Internal Revenue, established to carry out the provisions of the denatured alcohol act. Internal Revenue Commissioner Yerkes is in Europe making an inquiry into the operations of denatured alcohol laws in England, Germany and Holland.

PROFESSOR H. M. SAVILLE, of Columbia University and the American Museum of Natural History, is this summer carrying on explorations in Ecuador and Colombia.

DR. AUGUSTINE HENRY, known for his botanical researches in China and elsewhere, is at present in the United States, with a view to studying forestry conditions.

PROFESSOR SOLLAS, of Oxford University, assisted by Professor Lugeon, has conducted a party of students on a geological trip through the Alps.

THE department of vertebrate paleontology of the American Museum of Natural history has three expeditions in the field this season. Mr. Barnum Brown is continuing the search

for dinosaurs in the Cretaceous beds of Montana; Mr. Walter Granger is searching for fossil mammals in the Eocene formations of Wyoming, and Mr. Albert Thomson is exploring the later Tertiary formations of South Dakota.

Mr. Almon Harris Thompson, geographer of the U. S. Geological Survey since 1882, and previously in charge of geographic work under Major Powell, died at Washington, on July 31, at the age of sixty-seven years.

Mr. Joseph H. Batty, a well-known natural history collector and taxidermist, was killed by the accidental discharge of his gun, while on an expedition in Mexico for the American Museum of Natural History.

Sir Walter Buller, F.R.S., of Wellington, New Zealand, the author of important contributions to ornithology, died on July 19, at the age of sixty-eight years.

The underground water investigations will be conducted by the United States Geological Survey in the eastern United States as usual this summer, notwithstanding the reduction of the hydrographic appropriation by congress. Work is under way in Maine, Connecticut, Virginia, Florida, Kentucky, Ohio, Indiana and Iowa, and will be extended to New York, Pennsylvania, North Carolina, South Carolina and Minnesota later in the season. Mr. M. L. Fuller will supervise the investigations in the states mentioned.

Lord Selby will act as chairman of a Royal Commission which is to be appointed to consider the subject of experiments on living animals and the law relating thereto. Since the passing of the cruelty to animals act of 1876, no inquiry into its working has been held. The terms of the commission's reference will be "to inquire into and report upon the practise of subjecting live animals to experiments, whether by vivisection or otherwise; and also to inquire into the law relating to that practise and its administration, and to report whether any, and if so what, changes are desirable."

Nature states that the Natural History Museum has just received an important collection of bird and mammal skins from Mount Ruwenzori, East Central Africa, obtained with the aid of subscriptions from a number of persons interested in natural history. The collection is said to include a number of new forms, or of forms previously known only by a single specimen or so of each.

Plans have been filed in New York for a new museum to be built on Audubon Park Terrace, on 155th St., west of Broadway, for the American Numismatic and Archeological Society, of which Mr. Archer M. Huntington is president. The edifice will be 39.8 feet front and 63.3 feet deep, of concrete construction. It will be three stories in the classic style, with Ionic columns. The main floor and the second story will be devoted to the library and the meeting halls and exhibition galleries. The building is to cost $55,000.

The foundation has been laid for the building of a new Bacteriological Institute at Constantinople, intended especially to provide anti-toxic sera to the Turkish empire.

We learn from *Nature* that Mr. G. Montefiore-Levi, of Brussels, formerly a member of the Belgian senate and president of the Association of Engineers, has bequeathed a portion, probably exceeding £100,000 in value, of his residuary estate, to be applied for the prevention of consumption.

A press despatch from Washington reports that negotiations have been in progress for some time in London between the American embassy and the British Foreign Office relative to the protection of the seal herd in Bering Sea. Several years ago congress authorized the wholesale killing of all the seals on the Pribiloff Islands rookeries unless some arrangement could be made with the British government for the prevention of pelagic sealing. The award of the arbitrators in the Bering Sea case prescribing closed zones around the Pribiloff Islands, and a close season in the seal waters has completely failed to meet the needs of the case, hence the direction of congress. There has been some desultory correspondence between the governments at Washington and London for several years, but only recently has the matter been taken up in

earnest, and it is now believed that the embassy has succeeded in reaching a working agreement with the British government on a plan for the protection of seals, though the details remain to be developed. In the absence of exact information as to the scope of the agreement, it is believed here that its basis is a provision for the total suspension of sealing operations in Bering Sea for a term of years.

THE U. S. Civil Service Commission announces an examination on August 29, to secure eligibles from which to make certification to fill a vacancy in the position of chemist, Bureau of Science, Manila, P. I., at $1,500 per annum, and vacancies as they may occur in the Philippine Service requiring similar qualifications. It will not be necessary for applicants to appear at any place for examination. Their eligibility for the position will be determined upon the evidence furnished concerning their education, training and experience. It is desired to secure the services of a young man, energetic and capable, who has had several years of university training in a first-class institution, and this training should include a thorough foundation in all lines of the science, such as can be obtained by persons specializing in chemistry at any one of the first-class schools which make a specialty of giving chemical training. His main training should be in organic chemistry. The work required is of a routine nature and covers analytical methods and results, and the person appointed must be accurate and careful and he should have a good technique. There are in the bureau, however, other chemical positions which are practically for purposes of research. There is a considerable number of positions the salaries of which range from $1,600 to $2,250 per annum, and even higher, so that the person appointed to the position for which this examination is held, if he proves himself capable of filling higher positions, will have promotions open to him as rapidly as vacancies occur, and it is stated that such vacancies will not be too long delayed. The person appointed must not only have the ability and technique, but he must have ambition to push his work in every way possible and to keep abreast of literature. The laboratory is thoroughly equipped for all classes of chemical work.

MR. F. G. CLAPP, of the United States Geological Survey, has been engaged for several months in a study of the underground waters of the State of Maine, including both those in indurated rocks and in the drift. The investigation, which is now nearly completed, has brought out many points of interest in regard to the drift and has established the existence of deposits of several glacial and interglacial stages, including the equivalent of: (1) The supposed pre-Kansan till described by Fuller in southeastern Massachusetts, (2) the Jameco gravels (Kansan ?) found by Veatch and Fuller on Long Island, Marthas Vineyard, Cape Cod, etc., (3) the Montauk till (Illinoian ?) noted by Fuller on Long, Fishers and Block Islands, and in the drumlins about Boston, (4) Manhasset gravels described by Woodworth on Long Island, (5) the thick clays and overlying sands (Iowan ?) of southern Maine, (6) sands and tills of the latest ice invasion. Marked unconformities occur between beds 4 and 5 and between beds 5 and 6. There are indications that a still further subdivision of the drift may be possible.

UNDER the supervision of Mr. C. R. Van Hise, geologist of the United States Geological Survey, in charge of the section of pre-Cambrian and metamorphic geology, an economic investigation of iron ore deposits in Utah, Colorado and the Lake Superior region will be conducted during the coming year. Mr. Van Hise will be assisted by Messrs. C. K. Leith, E. C. Harder, F. Ward, A. C. Deming and W. Toellner. The mapping of the iron ores of the Iron Springs Special quadrangle of southern Utah was completed on July 1. A special topographic map on a scale of 1:45000, with 50-foot contour intervals has been made of an area of 225 square miles. The ore deposits themselves were mapped on a still larger scale of 250 feet to the inch. The maps and the report on the district will be published during the coming winter. This work was directed by Mr. C. K. Leith, who

was assisted by Messrs. E. C. Harder, F. J. Katz and Freeman Ward. On July 1, this same party took up the detailed mapping of the iron ores at Ashcroft in Pitkin and Gunnison counties and at White Pine in Gunnison County, Colo. These deposits are similar in character and geologic relationships to those already mapped in southern Utah. Study of them will aid in solving the general problem of the origin of the western iron ores. These deposits are also especially interesting, because they are likely to be of considerable commercial importance. It is hoped that during the year the final general monograph on Lake Superior geology, which Messrs. Van Hise and Leith have in hand, will be completed.

UNIVERSITY AND EDUCATIONAL NEWS.

The General Education Board, endowed by Mr. John D. Rockefeller with $10,000,000, has made appropriations to nine institutions on condition that three times the sum be appropriated from other sources. The appropriations, which amount to $312,500, are as follows: Coe College, Cedar Rapids, Ia., $50,000; Washburn College, Topeka, Kan., $25,000; Tulane University, New Orleans, $75,000; Wofford College, Spartanburg, S. C., $25,000; Furman University, Greenville, S. C., $25,000; Wake Forest College, Wake Forest, N. C., $37,500; Howard College, Birmingham, Ala., $25,000; Southwestern University, Jackson, Tenn., $25,000, and Mississippi College, Clinton, Miss., $25,000.

The late Dr. James Stewart, of Herts, has bequeathed about $135,000 to the University of Melbourne for a scholarship in anatomy, medicine and surgery, and an equal sum to other educational institutions in Melbourne.

We learn from the *Journal of the American Medical Association* that the new laboratory building for the use of the College of Medicine and Surgery, University of Minnesota, and the State Board of Health, will be ready for work at the beginning of the school year in September. The building is fireproof, and 60 by 213 feet. Plans are also being prepared for a building for operative surgery and experimental pharmacy, and for the new university hospital, made possible by the recent bequest of $150,000 by the late Dr. A. F. Elliott. Beginning with the college year 1907–08, the entrance requirement to the medical department will be two full years of college work. For several years the requirement for entrance has been one year of college work, but in view of the fact that nearly 60 per cent. of the present student body have had two or more years' college preparation, the regents felt justified in thus raising the standard for entrance.

Professor Norman Smith, of Glasgow University, has accepted a call to the Stuart professorship of psychology, Princeton University.

Dr. Warner Fite, adjunct professor of philosophy at the University of Texas, has been appointed junior professor of philosophy at Indiana University.

Professor R. B. Wylie, of Sioux City, Ia., resigns his position as professor of biology in Morningside College to become assistant professor of botany, in charge of morphology, at the State University of Iowa.

Miss Alice Robertson, Ph.D. (California), for the last two years assistant in zoology at the University of California, has accepted an instructorship in zoology at Wellesley College.

Dr. H. W. Marett Tims, demonstrator of anatomy in Cambridge University, has been appointed professor of biology at the Royal Veterinary College, London.

The Edinburgh University Court has appointed Dr. W. G. Smith, of Liverpool University, to the recently instituted George Combe lectureship in general and experimental psychology.

Professor F. S. Boulger has accepted the post of honorary professor of natural history and external examiner for the diploma at the Royal Agricultural College, Cirencester, in succession to the late Dr. Fream.

The electors to the Linacre professorship of comparative anatomy at Oxford University, vacant by the death of Professor Weldon, have elected to the chair Dr. Gilbert C. Bourne, fellow and tutor of New College, and university lecturer in comparative anatomy.